BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B69 05009

SUBJECT: Guided Entry Corridors for High Velocities
Case 310

DATE: May 1, 1969

FROM: S. B. Watson

ABSTRACT

The attached memorandum presents guided entry corridors for velocities between 37,000. fps. and 40,000. fps. for target ranges between 1200. N.M. and 2500. N.M. The overshoot bound is essentially independent of range but is a function of velocity. The lower bound is determined by large lateral misses for all velocities and ranges except for ranges of 2000. N.M. and 2500. N.M. at velocities between 37,000. fps. and 38,000. fps. where it is determined by undershoot misses. Based on a 0.1° grid in flight-path angle, all downrange holes were observed only at the 1200. N.M. range for a velocity of 40,000. fps. Holes due to lateral miss were found for ranges between 1600. N.M. and 2500. N.M. but were consistently below the 10.G line.

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MEMORANDUM FOR FILE

The study described in this memorandum was made to determine the guided entry corridors for velocities between 37,000. fps. and 40,000. fps. The model used for the simulations was the same as for C-prime with an L/D of .2969. The entry conditions are noted below:

Latitude	0.0 deg.
Longitude	0.0 deg.
Altitude	400,000. ft.
Azimuth	90. deg.
Target Latitude	0.2 deg.
Atmosphere	1962 Standard
Velocity	37000., 37500., 38000., 38800., 40000. fps.
Flight-Path Angle	-5.0 through -8.0 deg.
Earth-Fixed Range to Target	1200., 1350., 1400., 1600., 1800., 2000., 2500. N.M.

A corridor is defined by the shallowest and steepest flight-path angles which do not result in misses of more than 10. N.M. The entry corridors for the seven selected ranges are shown in Figures 1 through 7. The upper boundary is an overshoot limit whereas the lower one is either an undershoot or a lateral miss limit. The 10.G and 12.G contours are also shown in the figures.

In Figures 2 through 7 (1350. N.M. to 2500. N.M.) the upper boundary spans a range of flight-path angles between -5.1° and -5.7°. The overshoot sensitivity for these cases is 1000. N.M. or more for 0.2° in flight-path angle. The upper boundary in Figure 1 (for 1200. N.M. range) is similar to those for the longer ranges but requires steeper entry angles. It spans flight-path angles between -5.3° and -5.8°. The overshoot sensitivity is less for this 1200. N.M. range, 1000. N.M. for 0.3°.

During a high G region in the Upcontrol phase of the guidance, conditions may be present which allow the lateral miss to exceed the lateral capability and at the same time inhibit the guidance from reversing the roll angle to null the lateral error. This preoccupation with downrange logic can allow the lateral error to exceed the lateral return capability as much as 60. N.M. The resulting miss therefore has a large lateral component compared to its total magnitude. This lateral component can be as large as 50.% of the total miss. For a given lateral error during pullout the longer range targets which require more vertical lift, hence, are capable of less lateral correction, are the more constraining. The figures tend to confirm this. Figures 6 and 7 show cases where, for the lower velocities, the lateral miss ceases to be a problem. The lower limit is then determined by the undershoot miss. The absence of a lateral problem, in effect, widens the corridor for velocities between 37,000. fps. and 38,000. fps. The lower bounds are identified on the figures by the dominant miss, either lateral or undershoot.

A grid of 0.1 degree in flight-path angle was used in an attempt to locate holes in the corridor. The holes and the associated magnitude of miss are indicated on the figures. Three significant holes not attributable to lateral miss are the overshoots at -6.6°, -7.1° and 7.2° for a velocity of 40,000. fps. and a range of 1200. N.M. As seen from Figure 1, these are near the center of the corridor. All other holes are due to lateral misses and are consistently on the steep side of the corridor and for the longer ranges.

In summary, the overshoot bound, essentially independent of range, is a function of velocity. The lower bound, a function of both range and velocity, is complicated by the lateral logic which causes the lateral miss to dominate for all velocities and ranges except for ranges of 2000. N.M. and 2500. N.M. at velocities between 37,000. fps. and 38,000. fps. where the

undershoot miss is dominant. Based on the grid selected, holes were found for 5 of the 7 ranges tested. All downrange holes are found in Figure 1 and lateral holes are in Figures 4 through 7. If the corridor is restricted to the overshoot and 10G bounds, the guidance appears to be satisfactory for all the data run except for the shortest range (1200. N.M.) at the highest velocity (40,000. fps). Based on these constraints, the location of the corridor is approximately -6.35° $\pm$ .95°.

S. B. Watson

2014-SBW-mdr

S. B. Watson

Attachments
Figures 1-7

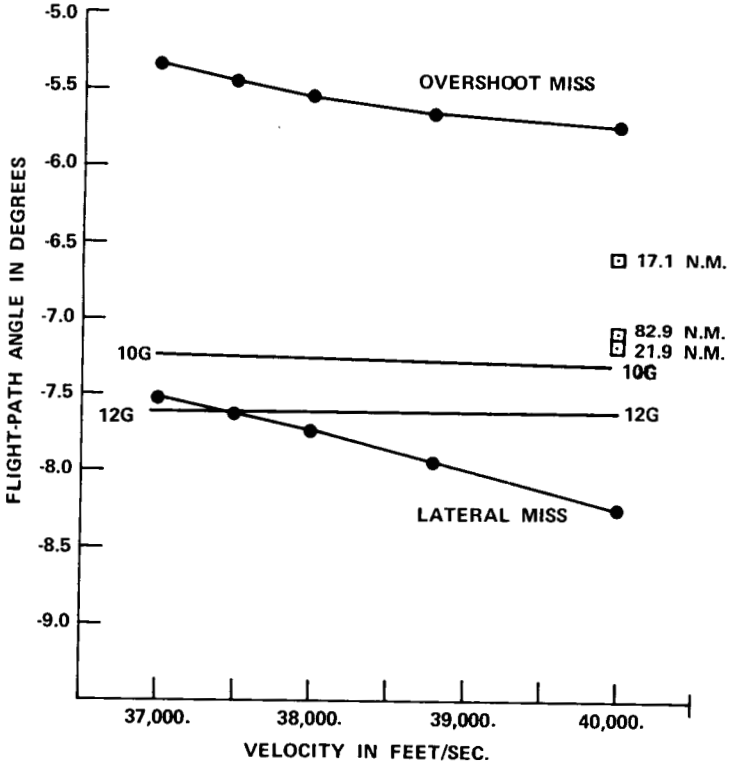

FIGURE 1 - ENTRY CORRIDOR FOR 1200. N.M. RANGE

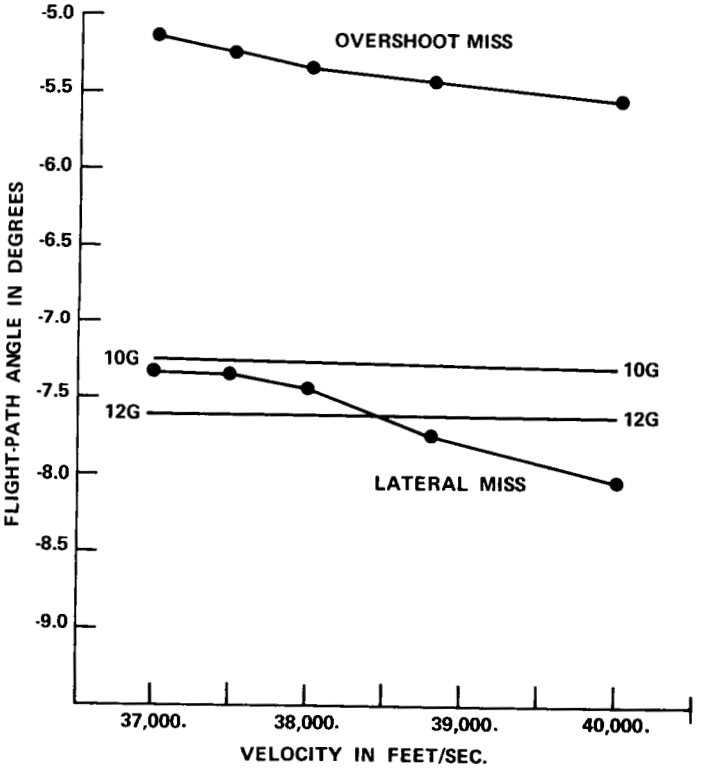

FIGURE 2 - ENTRY CORRIDOR FOR 1350. N.M. RANGE

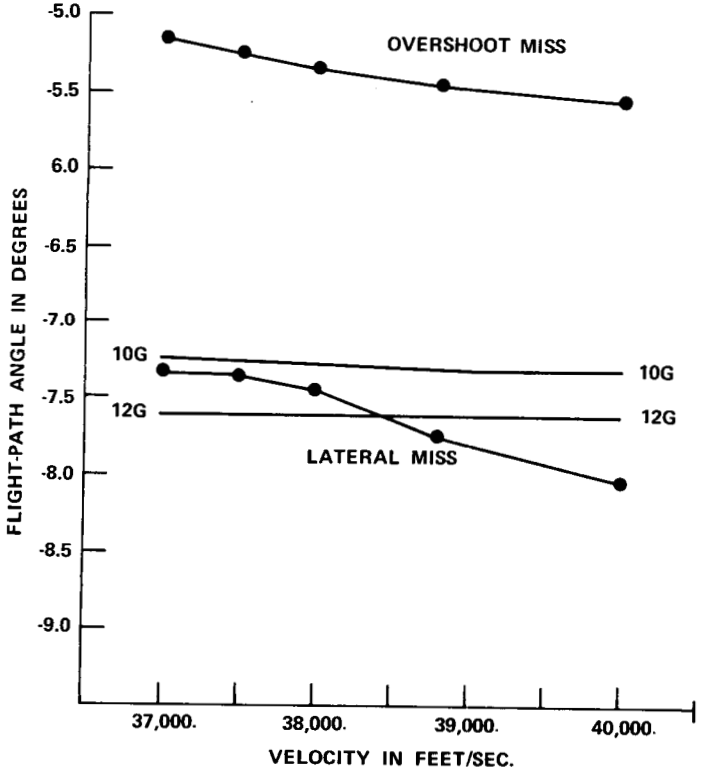

FIGURE 3 - ENTRY CORRIDOR FOR 1400. N.M. RANGE

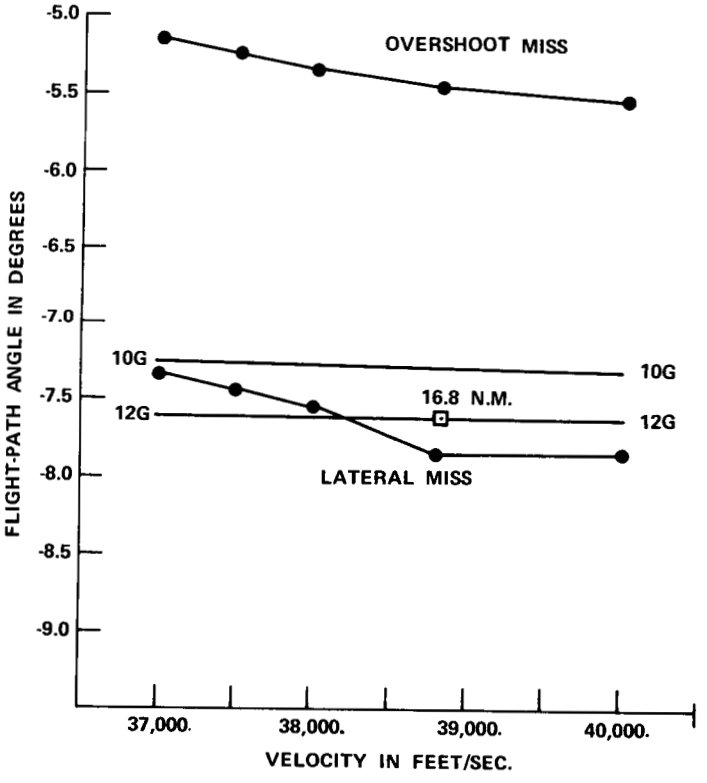

FIGURE 4 - ENTRY CORRIDOR FOR 1600. N.M. RANGE

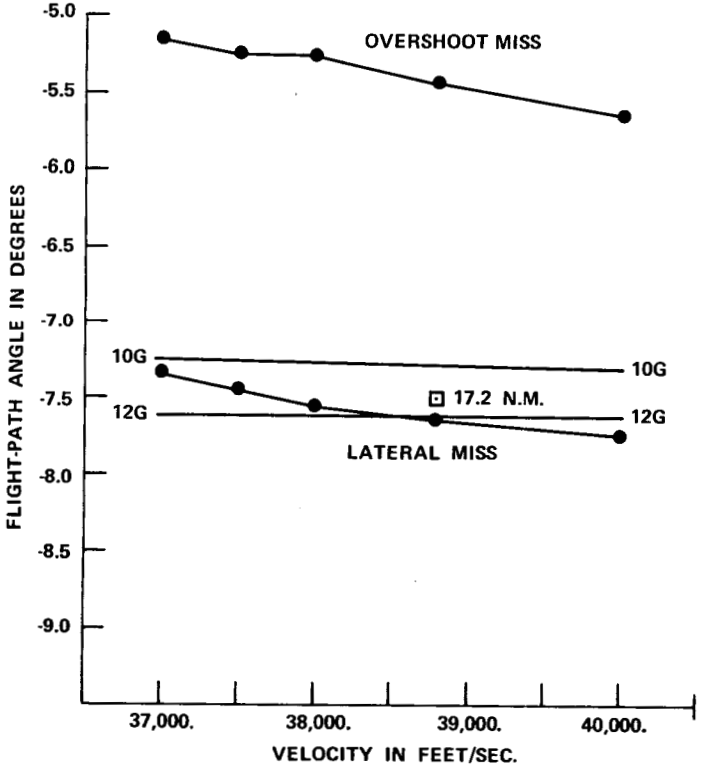

FIGURE 5 - ENTRY CORRIDOR FOR 1800. N.M. RANGE

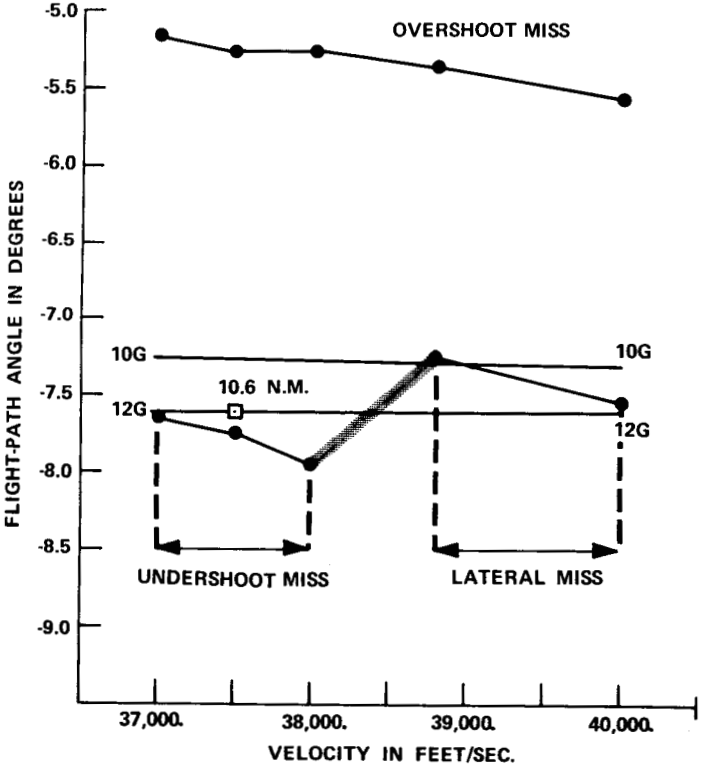

FIGURE 6 - ENTRY CORRIDOR FOR 2000. N.M. RANGE

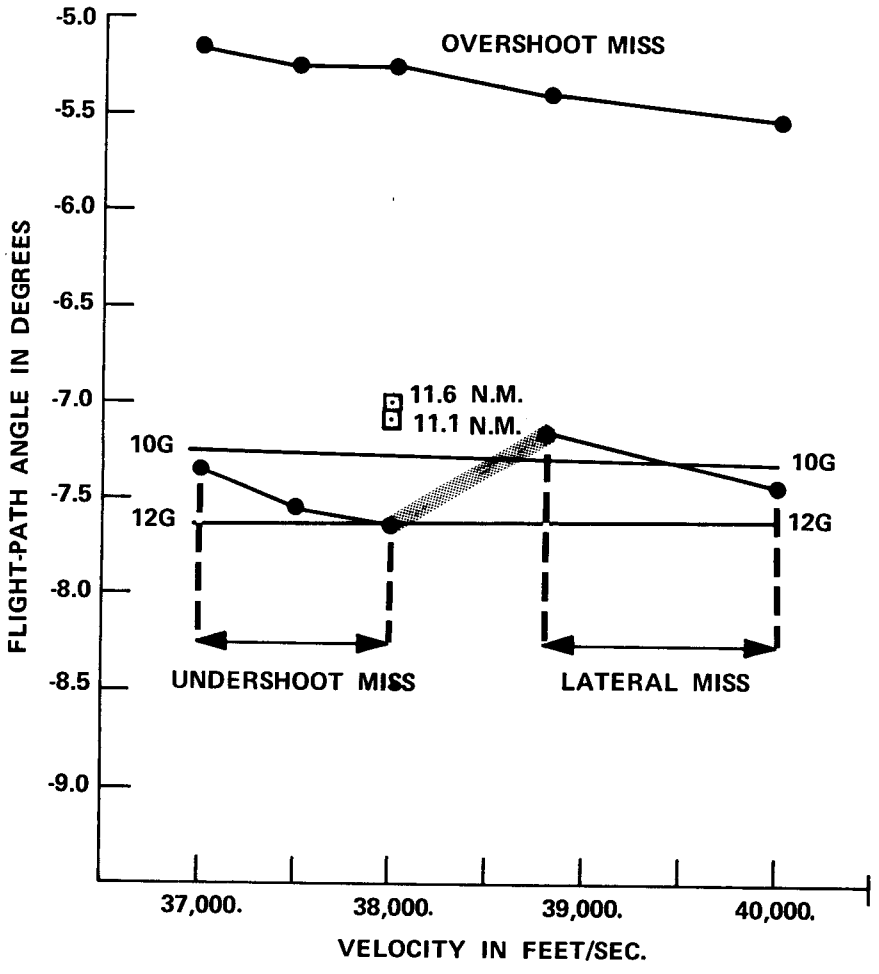

FIGURE 7 - ENTRY CORRIDOR FOR 2500. N.M. RANGE

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From: S. B. Watson

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